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South Dakota Farm and Home Research

South Dakota State University

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SPECIAL ISSUE: WATER QUALITY

South Dakota Farm & Home
RESEARCH

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About the cover

The cover photo shows the Missouri River bridge west of Gettysburg on highway 212. Our feature story for this special water quality issue of *Farm & Home Research* is a view of the history and future of Missouri River water policy from Governor George Mickelson. We also feature reports on rural water systems, the Water Resources Institute at SDSU, our individual responsibility for maintaining our water supply, Oakwood Lakes clean water project, and other water-related subjects important to South Dakotans.

photo: Emery Tschetter

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photo: Ag Communications

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R. A. Moore

Director's comments

by R. A. Moore

What's missing?

Water is a great resource. We have it; others would give much to have it. However, we haven't developed our water resources to the degree that was anticipated a half century ago, a decade ago, or even a few years ago.

What hasn't happened? What's missing?

Is it commitment? Finances? Consensus? A plan? A 3-year drought?

At the outset in any discussion we should agree that water development is more than water use. A development plan covers water needs of different parties with their own special needs, water conservation for the future, and issues of quantity and quality. Water development is addressed in laboratories, monitoring wells, political meetings, and in legislative halls. Water development comes in all guises; probably the actions of every one of us every day have some impact on water development in the state, whether we are consciously aware of that impact or not.

In a historical context, water development started early. Settlers dug wells and diverted streams. The Belle Fourche irrigation project was authorized by the Secretary of the Interior in 1904.

The biggest project agreement was signed in 1944. The Pick-Sloan Act provided for multi-purpose resource development: flood control for downstream states; expansion of navigation, recreation, and wildlife development; and generation of hydroelectric power. Five dams were constructed on the Missouri River in South Dakota.

The Oahe irrigation project was initiated in 1972 as part of the Pick-Sloan agreement that South Dakota be reimbursed for lands inundated by the Missouri River lakes. The irrigation project terminated in 1977 because of lack of consensus among citizens within the state on its economic feasibility, drainage, and wildlife and environmental impacts.

The CENDAK project followed the

termination of Oahe. It would have provided irrigation for nearly a half-million acres in its original form, but this later was reduced to about 300,000 acres. Little progress has been made on CENDAK in recent years.

The need for a comprehensive state water plan emerged frequently. In 1972 the state legislature gave the responsibility for developing such a plan to the South Dakota Conservancy District and also passed the South Dakota Water Resources Management Act to implement the comprehensive plan.

The plan emerged in 1980 as a group of specific projects and continues to evolve. Its goal: "to achieve the optimum overall benefits of the state's water resources for the general health, welfare, safety and economic well being of the people of South Dakota through the conservation, development, management and use of those resources."[1]

Responsibility to develop the plan was given to the Board of Water and Natural Resources, which identified the following areas as important for statewide policies and water resources management:

economic development,
irrigation,
water conservation,
domestic water,
tourism,
rural water systems,
lake restoration,
recreation,
flood control,
watershed management,
erosion control,
drainage,
water quality, and
water supply.

The state water plan consists of four programs: The State Water Facilities Plan (SWFP), the State Water Resources Management System (SWRMS), the Groundwater Research and Public Education Program (GRPEP), and the Solid Waste Management Program (SWMP).

For additional information and updates on the state water plan and the state water planning process, I encourage readers to contact the Department of Environment and Natural Resources for its annual report which becomes available in January of each year.

The plan functions well in those areas where we have agreement. In those areas without agreement, progress has been as slow as the Jim River in August.

Many successful economic ventures have their roots in agriculture or are directly tied to the state's number one industry. All forms of industry need stability. Irrigation provides that stability in raw materials and labor sources. But we have not made progress in irrigation. We do not need to irrigate all of our 44 million acres of agricultural land, and of course, we couldn't. But a million or two more would be desirable. The impact would be felt in far wider circles than just among irrigators.

The need to process more of our product within the state was indicated as early as 1887 when the Farmer's Alliance Political Party offered as one of the planks in its platform the following: "construction and operation of cooperative flour mills, packing plants, and other industries within the state to the end that the finished products only of the farmer should be shipped out of the state." H. L. Loucks, chairman of the party, added, "I would like to see the day when our wheat will all be ground in Dakota and the flour only sent abroad; when our livestock instead of being shipped out alive is slaughtered

[1] 1991 State Water Plan, Department of Water and Natural Resources, Pierre.

in Dakota and the cured product will only be exported."[2]

So modern Dakotans can't take credit for the idea of value-added!

But we have accomplished very little toward that goal in the 105 years since Loucks first announced it.

This issue of *Farm and Home Research* describes many of the water-related activities of the Agricultural Experiment Station and Cooperative Extension Service. An additional large amount, including irrigation and related research conducted at the James Valley Agricultural Research and Extension Center near Redfield, the Ag Engineering Farm near Brookings, and more recently at the Dakota Lakes Research Farm near Pierre, has been reported at other times in this publication.

photo: U.S. Department of the Interior

This 1976 photo shows construction at the Oahe pumping plant near Pierre. A multi-purpose resource development plan for the Missouri River seemed to be in place as early as 1944. Parts of the plan have been changed or abandoned, and some parts are still being argued. A statewide water plan emerged in 1980 and is functioning well where interest groups agree, but where there is no consensus—or no plan—progress in water development is "as slow as the Jim River in August," according to Experiment Station Director Ray Moore.

We appreciate the comments from Governor Mickelson that appear in this issue. Our governor continues to be a strong advocate for water development.

We have made progress in many water-related activities. But if we follow the state water plan, will we be adequately compensated for land given up to produce power, navigation, and flood control for downstream states?

We have some riverside irrigation, and the lakes have enhanced our tourism and recreational activities. Is this adequate?

We are a half century down the road from Pick-Sloan days. Even now, state and national leaders who made that agreement have largely faded into history. Either we settle this issue or we don't. If we don't, I hope we make that decision deliberately and with reasoned consideration of all outcomes. There is some justification not to settle: Some of our success in acquiring federal funding for various water projects perhaps may be attributed to the fact that the debate still goes on.

However we decide the issue, we must keep in mind that the comprehensive plan must include all sources of water--Missouri River, wells, lakes, streams, wetlands. The plan must also include all aspects of water use, protection from pollution, and conservation.

What will it take? If commitment, from whom? If consensus, how reached? ❑

[2]Early Days in Dakota, Edwin Torrey.

Dr. R.A. Moore is director of the Agricultural Experiment Station, SDSU.

New drainage methods may flush salts from soils

Irrigation saves many a crop in any one dry year, but all irrigation waters contain salts which must be removed from the root zone for long-term high yields. Salts flush out by either natural drainage through sand layers or through artificial structures such as buried drain lines. Most of the soils in eastern South Dakota are glacially derived. They have poor natural drainage and are expensive to artificially drain. This project investigates recent drainage technology and evaluates its economic feasibility. *Principal investigator: Dr. D.W. DeBoer, Department of Agricultural Engineering.*

Earthworms being counted in no-till environment

Water runoff is a major contributor to soil erosion and water degradation. The more earthworms in a soil, the greater the water infiltration rate and the less the runoff. The effects of farming practices on earthworm populations are being studied at Dakota Lakes Research Farm. *Principal investigator: Dr. D.L. Beck, Plant Science Department.*

Water flow network will trace chemical movement

Accurate tracing of contaminants moving through the topsoil layers and into ground water—the goal of this current research—is a first step in developing effective aquifer protection. Water may flow upward in the soil through micropores and downward through macropores—root channels, worm burrows, etc. Existing measuring techniques of water flow do not take into account pore size, consequently the direction of flow, and may confuse results. *Principal investigator: Dr. S.T. Chu, Department of Agricultural Engineering.*

Water resource policies affect economic development

Information is being collected on water supply and demand. Specific environmental, social, legal, and economic factors that affect water allocation among water users and policies that may minimize adverse effects of water allocations are being evaluated. These policies have an impact on water rights determination, storage rights, in-stream flow, irrigation distribution systems, beneficial use, and abandonment. *Principal investigator: Dr. D.R. Franklin, Department of Economics.*

Current soil tests under scrutiny

Present soil tests that evaluate soil fertility status are being improved. Updated soil tests will allow crop producers to more efficiently use plant nutrients; the increased efficiency will result in more economical crop returns and will decrease chances of ground water contamination. *Principal investigator: Dr. R.H. Gelderman, Plant Science Department.*

Road ditches may be direct routes into the aquifer

Road ditches may be extremely vulnerable pathways to aquifer contamination, since the soil, which normally acts as a natural blotter to trap impurities, was stripped from the ditch to build the road. When water flows in the ditch it might start out "clean," but ditches are also at times heavily sprayed for weeds. The movement, quantity, and quality of water in road ditch areas is being described. *Principal investigator: Dr. R.A. Kohl, Plant Science Department.*

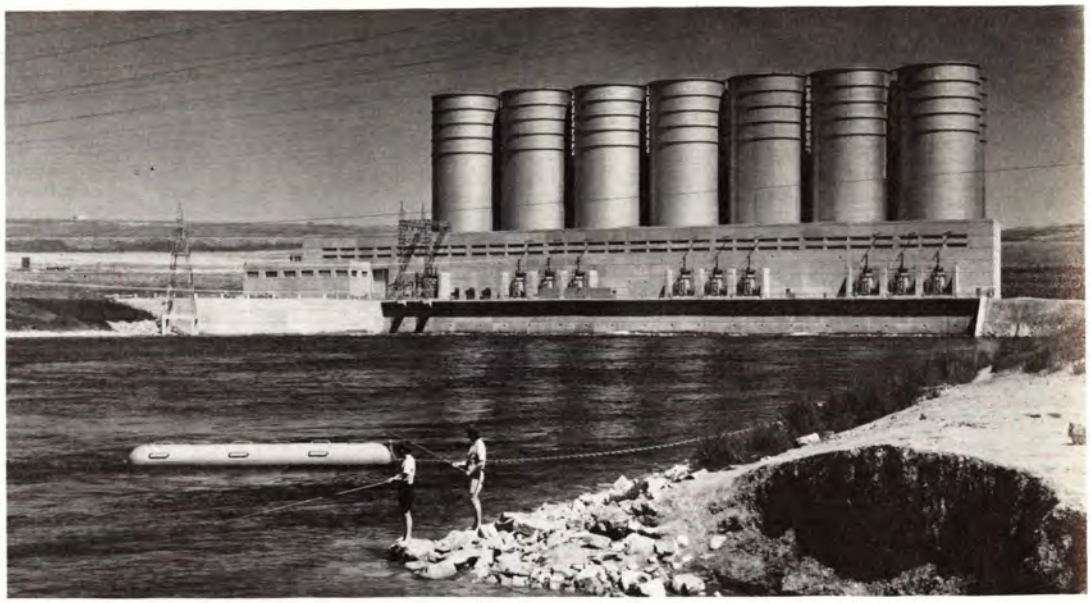

photo: U.S. Army Corps of Engineers

South Dakota's water history and its future

by
Governor George S. Mickelson

photo: South Dakota Governor's Office

Governor George S. Mickelson

Like the Missouri River itself, South Dakota's relationship with the river and its guardians has had its share of sharp twists and turns.

There have been rampaging floods, devastating droughts, unfilled promises made by the federal government, unexpected sources of economic development for Upper Basin states, low water levels, and lawsuits filed against federal agencies.

Admittedly, there have been both good and bad times in the state-river partnership. But, South Dakota's goal remains the same: to get the maximum use out of the Missouri River for the benefit of the state's residents and businesses.

To fully understand what South Dakota needs from its future relationship with the Missouri River, one must first know the history, which is highlighted by broken promises.

South Dakota and other Upper Basin states have never received the benefits they were promised by the federal government in the 1940s. In the Flood Control Act of 1944, more commonly referred to as the Pick-Sloan Plan, upstream states sacrificed much, but received little in return.

The Upper Basin states gave up 1.7 million acres of inundated lands to provide for downstream flood control. The states also sacrificed any opportunity to develop their Missouri River resources on their own.

In return, the Upper Basin states were to receive irrigation and industrial development commensurate with the sacrifices they were asked to make. It didn't happen.

Instead, the needs for navigation, irrigation and flood control in down-

stream states have taken a higher priority. The Missouri River resources, which are supervised by the U.S. Army Corps of Engineers, have constantly been allocated in accordance with the needs of the downstream states.

What has been ignored in the entire process is the growth and development of the recreation and tourism industries in the Upper Basin states, including South Dakota. These industries, virtually unheard of in the 1940s, have become tremendous assets in the 1990s.

Those industries account for more than $100 million a year in revenues for South Dakota industries. Thousands of people from throughout the world come to this state each year to enjoy our fishing, swimming, and boating areas.

Yet, the Corps of Engineers has continually refused to consider our ever-growing needs. Instead, it clings to an archaic master water control manual that gives higher priority to a dying navigation industry in downstream states.

Frustrated with such an attitude, the states of South Dakota, North Dakota, and Montana filed a lawsuit in the spring of 1990, seeking judicial review of the Corps' actions regarding water releases from the Oahe Reservoir.

The states argued that the Corps' plan was to lower water levels in the Oahe Dam to help the downstream navigational industry. Such action, the states said, had resulted in failed walleye spawns and serious damage to the Oahe fishery, especially at a time when the state was experiencing its most severe drought in three decades.

A federal district court in Bismarck, N.D., ruled in favor of the three states, issuing an injunction with the intent that existing water levels be maintained. On appeal to the Eighth Circuit Court of Appeals, the injunction was overturned.

Even in defeat, the Upper Basin states believed the Corps had heard their message—they were wrong. The Corps continued to give more preference to downstream needs, while admitting the master manual restricted the rights of recreation and tourism to use the river.

Frustrated again, the three states filed another lawsuit early this year in Billings, Mont., challenging the Corps' operating plan. The lawsuit is expected to be heard by the federal court sometime in 1992.

That is where we have been with regard to the Missouri River. Now, where do we go?

Since the first lawsuit was filed in 1990, media nationwide have characterized this issue as "a water war" between recreational and navigational interests. Our intent is not to eliminate the navigational industry.

Rather, we want the Corps to recognize the economic importance recreation and tourism have in the Upper Basin states, including South Dakota.

While we have been disappointed with the Corps' reaction to our needs, we are encouraged by the fact the agency has finally agreed to review and update its manual. This review and update will address, for the first time, the technical, environmental, and philosophical aspects of reservoir management. Finding a new and better way to conduct our river business is the only way we can all benefit and succeed.

We also are pleased representatives from Missouri River states, both Upper and Lower Basin, have been meeting to discuss river issues. Obviously, we won't agree on everything, but it is necessary for us to come together to resolve our problems.

The bottom line in this controversial issue is cooperation. All of the Basin states need to work together if we are to benefit from this great resource. It would be a shame if we allowed our conflicts to interfere with using the river to its fullest potential. ❑

photo: Robert Kohl

Three prize USDA water projects start on the land

by
Chuck Ullery

The whole issue of agricultural fertilizers and pesticides in ground water was coming to a head in 1989 when the USDA started its 5-year Water Quality Initiative providing additional money to address nonpoint source pollution. South Dakota, because of its national standing in water quality research, was able to move quickly to secure some of that funding.

"Nonpoint source pollution" in agriculture is diffuse pollution, just about any sources that don't come out the end of a pipe. In agriculture, such diffuse sources are soil erosion; land applied fertilizers, herbicides, or pesticides; and animal wastes.

The USDA Water Quality Initiative has two major components.

The basis of the first component is that we must act now, using known agricultural practices, before nonpoint source pollution becomes any worse. We don't have perfect answers, but we have enough knowledge to put some farming practices to use on the land now. We know they will work.

The second component is an effort to close in on those more perfect answers—new practices and new management systems—through research. South Dakota is a part of the Midwest Initiative, a multi-state effort to evaluate how production systems for corn and soybeans affect water quality. One variable is tillage. SDSU College of Agriculture and Biological Sciences

researchers are studying the differences between conventional and reduced tillage on irrigated corn over a shallow, sandy aquifer at the Aurora Research Farm east of Brookings.

The first part of the USDA plan is the most visible; it is work done on the land with cooperating farmers. Three federal agencies have major responsibilities—the Agricultural Stabilization and Conservation Service (ASCS) with financial support, the Soil Conservation Service (SCS) with technological support, and the Cooperative Extension Service (CES) with educational backup. A fourth major agency—perhaps most critical to the success of the project—is the local sponsoring group.

Only 16 demonstration projects have been funded nationally by USDA; the Big Sioux Aquifer Demonstration Project in eastern South Dakota, funded in 1991, is one of them.

Demonstration projects are combinations of educational, technical, and financial assistance. Their purpose is to accelerate the voluntary adoption of known technology like soil testing, integrated pest management, and irrigation scheduling to protect water quality.

Our main goal is to get known technology into use. We will help individual farmers put specific practices to work. The more significant part of the project, however, is that these farms then become model demonstration sites where other farmers can see that the programs protect water quality and are profitable to boot.

The Big Sioux Aquifer lies under about 1,000 square miles of prime agricultural land in 13 eastern South Dakota counties, from about Codington County south to Union County. It is very susceptible to contamination, since it is close to the surface. Publicity about the aquifer has captured the attention of people concerned about water quality, economic development, and human health.

The Big Sioux Aquifer is the sole water source for about a third of all South Dakotans, including residents of Sioux Falls, Brookings, and Watertown. Nitrate levels above the EPA drinking water standard of 10 parts per million have been found around Bruce and Aurora. Non-health threatening levels of pesticides were detected in the Oakwood Lakes-Poinsett area during the 1980s. Agriculture is described as holding "the smoking gun," being one—but not the only—suspect in contamination of the aquifer.

The goal of the Big Sioux Aquifer demonstration project is to put Best Management Practices, or BMPs, to work on agricultural land. BMPs are existing conservation and management practices that are cost effective for producers and also protect water quality.

We picked only a small part of the area overlying the aquifer on which to concentrate. This is about a 100,000-acre area roughly between Brookings and Sioux Falls. The cropping mix is 50-percent corn, 30-percent beans, 5-percent small grains, and 15-percent grassland and pasture.

Agency people will sit down with farmers who volunteer to participate and help them pick and choose from among the Best Management Practices a combination of conservation practices and management techniques that fits their particular situations. Landowners can choose a mix of structural, vegetative, and tillage systems; cropping rotations; and management styles that they feel they can handle and that meet acceptable soil losses and pollution standards.

We are concentrating primarily on fertilizers and pesticides, since they represent the greatest potential contamination threat to ground water. We will use Integrated Crop Management, which looks at cropping systems in a holistic or total manner.

Before fertilizing, we emphasize soil testing. The goal is to assure that fertilizer is efficiently and economically

Nonpoint Source Task Force

South Dakota water and water quality issues are in good hands says Chuck Ullery, Extension water and natural resources specialist at SDSU."In the final analysis, water problems are local problems, as individual as soil profiles, watersheds, and people themselves. So, within state and federal guidelines, people in South Dakota solve South Dakota problems."

Those guidelines are set by the federal Environmental Protection Agency and the state Department of Environment and Natural Resources, agencies jointly responsible for water quality regulatory programs. The state agency enforces EPA requirements as a minimum, but may add more stringent programs if citizens want them.

In 1988, EPA set up the framework to address nonpoint sources of pollution, mainly from agricultural fields and from urban and forested areas. This was the 319 program, named after a section in the 1988 Clean Water Act. All states formed 319 task forces.

In South Dakota, the 319 Nonpoint Source Task Force is the coordinating body for the review and direction of federal, state, and local governmental programs in nonpoint source pollution control. It prioritizes water bodies for action.

The South Dakota Department of Environment and Natural Resources is the lead agency. Membership on the task force consists of nine federal and six state agencies, SDSU and the Water Resources Institute, and numerous commodity and interest groups. Membership is open to any organization, whether private or public, which has an interest in water quality.

used—enough to obtain the desired yield but not so much that excess can be lost to leaching or runoff.

Then, if chemicals appear to be necessary, within label restrictions, we might recommend compounds with formulations or recommended rates that are less likely to leach or run off.

There are also other options. We will discuss different crops, different varieties, different tillage systems, all of which can break an insect cycle. The farmer will also determine the economic threshold of insect infestation that is acceptable; there's no point in spraying before that threshold is reached.

There are no big surprises in many Best Management Practices. That's the point. Put together in individual-package programs for each farmer, these management options are economically feasible and environmentally sound. Economics and environment are the keys that will encourage their use.

Another group of projects funded by USDA has a different twist: the emphasis is to go into the project area and put on as much in land treatment practices as we can.

These "hydrologic unit areas" are set up to solve a specific water quality problem. After the state worked through a prioritizing schedule and named Richmond Lake near Aberdeen and the Lower Rapid Creek basin as top needs, the USDA agreed to work with farmers to put practices on the land that will alleviate their problems.

These two hydrologic units are two of only 74 funded by USDA in the last 2 years across the nation. They are organized like demonstration projects, with the ASCS providing financial assistance, the SCS technical support, and CES offering educational programs.

Lower Rapid Creek is approximately a 20- by 10-mile area between Rapid City and the Cheyenne River. The area is a combination of intensive irrigated agriculture, feedlots, and urban sprawl.

The creek lies above a shallow allu-

vial aquifer with a high water table, in many places less than 5 feet below the surface. Water quality in both creek and aquifer is deteriorating. Nitrate content, salinity, coliform bacteria, organic matter, and suspended solids are all higher than they should be.

The creek is used for irrigation, and the distribution ditches are old and leaking. This means an excessive amount of water is taken from the creek and cycled to an already high water table. Stream banks are eroding, and feedlots and septic tanks also contribute contaminants.

The Lower Rapid Creek Project is designed to reduce seepage in the irrigation distribution ditches, and farmers will be shown improved water management practices that make more efficient use of water and reduce movement of water, nutrients, and chemicals into the aquifer and creek. Feedlot managers will be helped to construct storage facilities or dikes. Septic tank problems are not covered by this agricultural project.

Richmond Lake is a man-made impoundment on lower Foot Creek about 8 miles northwest of Aberdeen. It covers 829 surface acres and averages 15 feet in depth, with a maximum of 29 feet. A recreation area is heavily used by Aberdeen residents; the public beach has been closed on occasion because of high levels of fecal coliform bacteria.

Richmond Lake's problem is extreme eutrophication, much like many other South Dakota lakes. Eutrophication is a natural aging process; the end result is a complete filling in and drying up of a water body.

At Richmond Lake, degradation of water quality has been accelerated by nonpoint source pollution. The lake is characterized by high in-lake nutrient levels, sometimes severe algal blooms, low oxygen levels, poor clarity, and sporadic fecal coliform problems.

Management practices are being developed with approximately 45 farm operators in the 85,000-acre watershed. The objectives are new or improved animal waste management systems, shoreline stabilization, fencing cattle away from the lake and giving them alternative watering facilities, and Best Management Practices in the watershed.

Participation is voluntary, as it is in the other projects. All three projects are funded from USDA through three existing agencies. SCS is primarily responsible for providing technical assistance for Best Management Practices. The Cooperative Extension Service provides educational programs and technical inputs for pesticides and fertilizers. The ASCS provides cost sharing to producers to help them implement practices.

The USDA effort is only part of the state's plan for Richmond Lake. The possibility for contamination by improper waste disposal from cabins around the lake is being examined by the South Dakota Department of Environment and Natural Resources.

The Richmond Lake project was funded in 1990; the other two projects started up in 1991. All will run for 5 years.

They were chosen because there is local enthusiasm for them—Richmond Lake volunteers, for example, are using rock donated by area landowners to stabilize the shoreline. Local support is the key.

We have much of the know-how already available to help us manage and improve our water resources. Water is a common asset of all people. The more of us who become involved in its care and protection, the better are the chances that the action will serve the interests of all of us. ❑

Dr. Charles Ullery is Extension water and natural resources specialist at SDSU. He recently spent a year in Washington, D.C., with the Federal Extension System. His specific responsibility was the management of water quality demonstration programs.

photo: Duane Hanson

Water Resources Institute puts together the pieces

"When you help make the rules, you have some advantages."

Al Bender, who led the SDSU Water Resources Institute (WRI) as acting director for 4 years, was referring to South Dakota's position in national water quality work.

"We got out in front because of our research and demonstration programs of the past, specifically the Oakwood Lakes Rural Clean Water Project," Bender said.

The Oakwood project was one of only two in the nation that dealt with ground water, according to Bender. "We learned a lot about how ground water moves around from the Oakwood project."

An even more important reason for South Dakota's pre-eminence, Bender said, is that, early on, the WRI cast its lot with USDA when water quality issues were involved.

"In the late 80s, we realized that our future would depend on the USDA. That's where the money was."

When President Bush's water quality initiative of 1989 designated USDA as the lead federal agency in protecting water from nonpoint source pollution, the South Dakota institute was in position to move. At the same time, Gov. Mickelson had developed the state Centennial Environmental Protection Act, with a provision to fund research and public education on ground water, Bender said.

The original mission of the institute was to coordinate all water related research in South Dakota regardless of the funding entity. The goal was to avoid duplication and use available funds in the most productive way. "That's been watered down a little, because there are so many more agencies involved in water work now, but for SDSU and for research, it still holds. We still have a handle on what's going on," Bender said.

Water Quality Lab can check for pesticides

The Water Quality Lab, part of the Water Resources Institute at SDSU, is now equipped to analyze for pesticides in water samples submitted by private South Dakotans.

"We can tell, within category, what pesticide it is," said Patricia Nohr, chemist for the lab. "It's a new service, primarily used in research studies but also available to the landowner."

A test for pesticides should help alleviate concerns for human and livestock health if a person has had a chemical spill or has other reason to believe a well has been contaminated, she said.

People mostly want their water analyzed for agricultural purposes—for irrigation and for farmstead use which includes livestock, lawn and garden, and human uses, said Shirley Mittan, head lab technician.

"Some problems that lead people to send us samples have to do with livestock," Mittan said. "Scouring of baby pigs or baby calves alerts producers to possible water quality problems."

Sulfates, which occur naturally in the water, are implicated in scouring, or excessive diarrhea.

They're difficult to pin down, however. The lab has to consider all other inorganic salts. Bicarbonates and calcium, magnesium, and sodium chlorides can cause health problems in livestock, and a mixture of the salts seems to do the same degree of harm as a high concentration of just one. Nor can microorganisms be ruled out as a possible cause.

Mittan advises producers to check with their veterinarians before submitting samples if livestock health problems or deaths have occurred.

The lab is EPA certified to check water samples for nitrates. Excessive nitrates contribute to inadequate oxygen transport in the body. In extreme cases, "blue baby syndrome" in infants is the result.

The lab also tests irrigation water for compatibility with soil. Homeowners commonly request analysis for iron content, hardness, and use on lawns and gardens.

"When we find a sample high in sodium, we advise homeowners to water only a couple of times a summer, and really soak the ground to move those minerals down past the root zone." Mittan said.

Hardness is a common complaint but is usually only a nuisance and can be alleviated by using a softener. Iron and manganese are also "nuisance" elements.

The lab also conducts water quality analyses for researchers at SDSU and the Division of Conservation in Pierre. A new project involves pesticide flows through landforms.

"Most people probably should have their water tested once a year, at least. And they should keep the records and compare them—that's the key. They may have good water, test after test, and begin to think they're just throwing money away on analysis," Mittan admitted. "But when something shows up that wasn't there a year ago, maybe a crack has developed in the well casing and they're getting contamination."

A bacterial count is another determination of whether water is safe for human consumption; the lab at the State Department of Health conducts this test, Mittan said.

For help in obtaining analyses from the Water Quality Lab, contact your county Extension agent or the lab at the Agricultural Engineering Department, SDSU, Brookings 57007, phone 688-4211.

"...The WRI has to be out front, out around the curve, watching ahead, so that our researchers and citizens can have an idea of what's coming up."

--Al Bender

"The WRI can go where the action is—we can take chances," Bender said. "In fact, the WRI has to be out front, out around the curve, watching ahead, so that our researchers and citizens can have an idea of what's coming up."

The idea works, he said.

"Believe me, water quality is experimental in fitting together all those pieces—research, demonstration, education, technical assistance—to make them interact and solve our problems."

He cited the USDA special research initiative on pesticides, ground water, and corn and soybean production as an example. The intent of the initiative is to follow the process of contamination

SDSU Water Resources Institute current projects

Research projects in the Water Resources Institute (WRI) include the following:

- "Northern Corn Belt sand plain management system evaluation areas," at SDSU Aurora Farm. *Principal investigators: Alan Bender and John Bischoff, WRI; Dr. David Clay, Dr. Sharon Clay, and Dr. Tom Schumacher, Plant Science Department.*
- "Characterizing the impact of soil type and land use on the transport of contaminants to a shallow unconfined aquifer." *Principal investigator: John Bischoff, WRI.*
- "Tillage effects on agrichemical fate in the soil and aquifer." *Principal investigators: Dr. David Clay, Dr. Sharon Clay, and Dr. Tom Schumacher, Plant Science Department.*
- "Water management on glacial soils of south-central South Dakota." *Principal investigator: Dr. Darrell DeBoer,* Department of Agricultural Engineering.
- "Determining water quality trends of 21 deep lakes in South Dakota." *Principal investigators: David German, WRI, and Dr. Bob Bell, Biology/Microbiology Department.*
- "Development of a detailed watershed protection plan for the Pickerel Lake watershed." *Principal investigator: David German, WRI.*
- "Rural Clean Water Program: quantifying water quality improvements from animal waste management at Oakwood Lakes. *Principal investigator: David German, WRI.*
- "Isolation and evaluation of indigenous soil microorganisms capable of biodegrading petroleum hydrocarbons." *Principal investigator: Susan Landon-Arnold, Department of Biology, Northern State University.*
- "Effectiveness of clay liners in feedlot runoff storage systems." *Principal investigators: Dr. Vernon Schaefer and Delvin DeBoer, Department of Civil Engineering.*

by production systems, find out how pesticides end up in ground water, and discover, if possible, where in this process that contamination can be halted.

The initiative meshed with the interests and talents of scientists on the SDSU staff, Bender said, "and certainly it meshed with the need-to-know of corn and soybean growers.

"The project at the SDSU Aurora Farm—we chose irrigated corn over shallow, sandy aquifers to work with—has demonstration components in it. Bob Kohl, Sharon Clay, Dave Clay, and Tom Schumacher, all SDSU plant scientists, are in the first year of new research projects. Diane Rickerl has done work on nitrogen movement and used radioactive nitrogen as a tracer."

Several of these scientists also have obtained competitive grants, and they also have access to funds awarded through the Experiment Station.

"Do you know why USDA was given the charge by the President to fight nonpoint source pollution?" Bender asked.

"Because USDA is an agency for social change. Most people don't see that. But the conservation and environmental groups do; they look to farm bills as a way to make things happen."

That means, he said, that the USDA and its affiliated agencies and institutions like SDSU have to deliver.

"We have to make voluntary programs work. Farmers have escaped regulation just about as much as they can.

"We'd better enlist the help of those conservation and environmental groups. We who live on the land are the guardians of land and water. We have to get out in front and make agriculture the lead advocate for our resources," he said. ❑

Al Bender, assistant professor of ag engineering, also has soils research, computer programming, and meteorology in his background. He has been a professional aviation forecaster, and, as of August 1991 is state climatologist. Dr. Mylo Hellickson has become WRI director. The writer is Mary Brashier, Experiment Station publications editor in the Department of Ag Communications, SDSU.

How much do puddles contribute to chemical movement into the soil?

Even if a field looks flat, water will pond in microdepressions after a rain. Where water collects, waterborne chemicals may also collect and eventually work down into ground water. Ridge tillage and fertilizer placement in the ridge may halt some of this movement. Methods are being devised to measure an erosion-productivity index of such soils. Management systems to improve the productivity of eroded soils will be identified. *Principal investigator: Dr. T. Schumacher, Plant Science Department.*

Environmental emphasis moves into the root zone

The decade of the 90s will be characterized by concern for the environment. This project verifies the ways chemicals move within the root zone and will provide a better understanding of the relationship of agricultural management practices to the soil environment. When scientists understand the environmental fate of pesticides, nutrients, and salts from irrigation water, farmers will be able to maximize productivity while simultaneously protecting a fragile environment. *Principal investigator: C.G. Carlson, Plant Science Department.*

What happens to herbicides in the dead of winter?

Herbicide movement in frozen soils is being mapped to measure the riskiness of fall applications. Alternative crop management practices, such as changes in crop rotations or reducing herbicide rates, will also be evaluated for shifts in weed species and weed populations. These data can then be incorporated into best management practices for weed management in crop production. *Principal investigator: Dr. S.A. Clay, Plant Science Department.*

Soil productivity ratings are being updated

Maps, reports, and tables of soil information are being created, with more detailed chemical and physical investigations of major benchmark soils in southeastern and north-central South Dakota. These data will be the basis of better land use decisions in rural and economic development. Detailed studies of soils, vegetation, and hydrology in northeastern South Dakota will help in the identification and management of wetlands. The long-term (50 to 100 years) impact of cultivation on selected soils is being examined. *Principal investigator: Dr. D. Malo, Plant Science Department.*

Black Hills cattle stocking rates affect Rapid Creek study results

This study on range condition and soil water relationships dovetails with three federal-agency projects. The USDA Lower Rapid Creek Hydrologic Unit study is focused on improving irrigation efficiency. The Soil Conservation Service project is on the creek's drainage area. The U.S. Forest Service project identifies critical riparian areas on the Black Hills National Forest. All projects are closely related to stocking rates for cattle on private and public grazing lands and on management of ponderosa pine. *Principal investigator: Dr. R. Gartner, Department of Animal and Range Sciences.*

photo: Jerry Leslie

Oakwood-Poinsett research project provides blueprint on protecting water

The 10-year federal Rural Clean Water Project (RCWP) examining surface and ground water in the Oakwood Lakes and Lake Poinsett watersheds in eastern South Dakota drew to a close in December 1991.

The investigators have summarized and reported the mountains of data gathered on how to help keep our lakes and ground water clean.

Information gleaned from the study of farming practices and their effect on water quality will serve as a blueprint for future federal and state policies to manage agricultural nonpoint source pollution.

The RCWP, as it was abbreviated, was one of 21 USDA pilot demonstration projects in the nation. It brought South Dakota $4.39 million through cooperating state and federal agencies, including more than $744,000 for cooperating farmers to employ certain agricultural "Best Management Practices (BMPs)" within the project area.

Three USDA agencies provided the leadership for the project. ASCS provided cost-share funds to help producers adopt BMPs while SCS gave producers the technical assistance to adopt them. The Extension Service contributed by providing educational programs.

The goal of the project was to reduce the amount of total nitrogen, pesticides, water, sediment-borne contaminants, and animal wastes from entering the ground and surface waters.

To accomplish this, the project contracted with farmers in the watersheds to implement BMPs, such as conservation tillage, fertilizer management, and waste management systems on 10 livestock operations.

In the meantime, streams, lakes, and ground water were monitored to see if these recommended management practices, when applied in the watershed, would improve surface and ground water quality.

In addition to the implementation of BMPs in the watershed, the project expanded to include a Comprehensive Monitoring and Evaluation (CM&E), an Oakwood Lakes System Study (OLSS), and an Agricultural Chemical Leaching Study (ACLS), the three of which basi-

cally monitored the water and its quality as it moved through the soil, through the aquifer, through the streams, and through the lakes.

During the project about 157 farmers contracted to perform BMPs on about 48,000 acres in the watershed.

Observers did detect some improvement in surface water, but couldn't determine any effect on ground water as a result of improved farm management practices.

Briefly, project findings told investigators that protecting ground water and surface water from agricultural contamination will be a demanding task.

Demonstrated here is that to protect water quality, each farm field should be examined in detail for its soil types, for its slopes, and for its closeness to the water table to estimate the risk of farm fertilizers and pesticides leaching into the ground water or running into streams and lakes.

Then, each field must be farmed appropriately using needed land-treatment practices and management to minimize water pollution while maximizing yields and profitability. In some cases the new farming techniques may have to be found through research.

That's an assessment from Dr. Charles Ullery, Extension water and natural resource specialist at SDSU who was responsible for information and educational activities for the project.

Data from the project were incorporated into an in-service training program on water quality for Extension, SCS, and state agency staff.

A prescription planning process was developed which will permit agricultural professionals to make specific, environmentally sound management decisions about fertilizer and pesticide applications and management.

The news for the Oakwood Lakes chain, located northwest of Brookings, is not encouraging, says David German, research associate with SDSU's Water Resources Institute, who directed the Oakwood Lakes System Study. The lakes are hypereutrophic, or overproductive of algae and subject to fish winterkill. Like most shallow prairie lakes, they are slowly dying, and the best that can be done now is to slow down that process and perhaps extend their life. Improving the water quality is doubtful.

The Oakwood Lakes chain was rated at being near the top of algae-production potential that a lake can reach.

While the lakes are currently acting as catch basins for silt, nitrogen, and phosphorus from farm runoff, stopping that in-flow would not stop or reduce algae bloom, since things have already gone too far, researchers suggested.

The Oakwood Lakes chain has apparently been in the process of silting in and receiving plant nutrients since far before white settlers brought intense farming practices to this country.

The bottom of the lake has several feet of dark grey muck that is so loaded with phosphorus, nitrogen, and silt that the nutrients keep circulating back up through the water, turning the lakes green with algae bloom in the heat of the summer and choking off fish life in the winter.

Wave action, bottom-feeding bullheads, and biochemical reactions churn the nutrients from bottom to top in a never-ending cycle.

The news for the Big Sioux Aquifer, the underground drinking water supply for much of eastern South Dakota, was more encouraging.

While minute quantities of pesticides were showing up in about 11 percent of ground water samples from monitoring wells, they were in very low concentrations, did not last long, and for the most part were one-time events during precipitation.

A few of the detections exceeded safe levels permitted in drinking water for humans; but, overall, the quality of the ground water is very good.

Pesticides typically showed up just after a rain, thaw, or other ground water "recharge event."

That the detections did not last long indicated pesticides either rapidly degraded or were quickly transported away from the well zone after the sampling, researchers wrote.

John Bischoff, research associate in the Water Resources Institute, showed that cracks, worm holes, and other "macropores," when they arise, can swiftly transport into the aquifer a heavy rain and pesticides along with it. Bischoff also found there were more large pores under reduced tillage than under conventional tillage, indicating that these contaminants can move down faster to the water table under reduced tillage.

Researchers believe pesticides may remain in drier soil a year or more, but rapidly degrade when they get to the zone in the soil that is saturated with water.

A total of 1,628 water samples were collected from 73 monitoring wells and analyzed for 22 agricultural pesticides from 1984 through 1990. Pesticides were found in 184 samples from 37 wells, about 11 percent of the samples from 51 percent of the project's monitoring wells.

Three herbicides—alachlor (Lasso), 2,4-D, and dicamba (Banvel)—accounted for 61 of the detections, although Sencor, Dual, parathion, Dyfonate, Treflan, atrazine, Bladex, Tordon, and Lindane were also detected in a few samples. Dyfonate, parathion, and Lindane are insecticides.

The detections of alachlor, 2,4-D, and dicamba generally correlated positively with use at the field sites, although Sencor and parathion had no application history during the life of the project on any field site in the RCWP program.

Researchers theorize these pesticides must have been applied prior to the start of the project in 1981 or may have come from an off-site source through surface runoff of an adjacent field or airborne transport. Another possibility is that degradation reduces one pesticide to another compound detected by the identification equipment.

"Concentrated leaching of pesticides resulting in sustained ground water contamination does not appear to be a problem at any one of the field sites in the RCWP program," said the draft of the final, comprehensive project report.

Further, nitrate levels above 5 miligrams per liter were found no deeper than 20 feet below the water table, except for two samples in 1989. Through 1990, researchers had examined 3,092 ground water samples from 106 wells for nitrate nitrogen.

This means that nitrates are moving to the ground water, but they don't move far into the ground water. This may be due to denitrification," said Jeanne Goodman, natural resources engineer for the South Dakota Department of Environment and Natural Resources. Denitrification is the process by which biological organisms transform nitrates or nitrites to gases.

Goodman is the project manager for the CM&E component of the project. She was responsible, along with Mike Kuck, project coordinator from the Soil Conservation Service, for organizing reports from all investigators into one readable, comprehensive report.

A 15-page fact sheet summary of the report was also being prepared by Ullery and Dr. Gregg Carlson, Extension rural clean water specialist, for release in 1992.

A study of the fish population of the lakes found 15 species present, but black and yellow bullheads made up about 70 percent of the catch over 3 years of study. Primary game species like walleye, northern pike, and yellow perch made up only 6.4 percent of the fish captured.

Winterkill caused by oxygen deficiency limits the species richness, researchers said, and encourages such species as bullheads, fathead minnows, common carp, and bigmouth buffalo which can better tolerate low oxygen.

Researchers said bullheads and carp encourage algal bloom by stirring up the bottom sediments and nutrients. And fathead minnows and buffalo consume zooplankton which feed on algae. Managing the fish population to increase the game fish could improve the condition of the lake, but fish are susceptible to the winterkill common in shallow prairie lakes, the researchers wrote in their final report.

Researchers suggested that fisheries managers harvest bullheads, common carp, and bigmouth buffalo or stock additional predators such as flathead catfish, but cautioned that any fish management program would be hampered by winterkill.

The volume of accumulated data from 10 years of research by a dozen or more researchers, plus their assistants and technicians, is staggering. But here are some more key findings from the research:

Best Management Practices, even if they do reduce phosphorus and nitrogen entry into the lakes, are not likely to improve water quality in Oakwood Lakes. The sediments already there contain phosphorus and nitrogen to support large algae blooms even in years when tributary loadings are low.

Application of herbicides followed by quick and heavy rain or thawing of snow and ice apparently triggered many of the pesticide detections in ground water. Contamination occurred by water flow in cracks, worm holes, and other macropores.

Label-rate pesticide application apparently does not have a significant long-term negative effect on ground water quality.

Herbicides apparently can remain largely unmoved in dry soil for months and years, staying available to be washed into the ground water with a sudden, heavy rain. This led researchers to recommend ag policy which encourages use of effective pesticides which rapidly decompose or break down in the soil.

Lake Poinsett and Oakwood Lakes, because of their locations, serve as focal points of recreational activities for Watertown, Brookings, Huron, and Madison. The recreation activities here are fishing, boating, swimming, water skiing, camping, and golfing.

The heavy recreational use of the lakes and the tendency of the lakes to bloom in the summer entered into the selection of this area for the project site.

In the watersheds surrounding the lakes, 157 farmers contracted to apply improved management practices on 48,088 acres.

While producers were concerned about water quality, their willingness to adopt improved practices or management to protect or enhance the water quality is driven principally by how the practice or management affects their profits, the report stated.

The cost factor apparently entered into the fact that only one of the 10 livestock operations in the area installed an animal waste management system during the life of the project.

Although cost-sharing was the main reason for participation, some farmers did continue the practices after their contracts ended.

This study was a multi-agency and multi-discipline study administered by the U.S. Agricultural Stabilization and Conservation Service. These agencies contributed: South Dakota Department of Environment and Natural Resources; from SDSU, the Cooperative Extension Service,the Department of Wildlife and Fisheries, Plant Science Department, the Biology Department, the Agriculture Engineering Department, the Water Resources Institute and the Water Quality Lab; U.S. Environmental Protection Agency; Economic Research Service; and Soil Conservation Service. ❑

The writer is Jerry Leslie, communications specialist in the Department of Ag Communications, SDSU.

photo: Jerry Leslie

Photographer's position gives the impression that these rows run right down to Oakwood Lake. The ground is actually rather flat and is laced with grassed waterways and constructed sediment traps. The goal of the Rural Clean Water Project was to reduce amounts of total nitrogen, pesticides, water, sediment-borne contaminants, and animal wastes from entering ground and surface waters. There has been some improvement in water entering the lakes, but the Oakwood Lakes system already contains enough nutrients to produce algal blooms in summer and potential fish kills in winter for years to come without any more added nutrients.

photo: Ag Communications

Voluntary farming practices more palatable than regulations

The completion of the Oakwood Lakes-Poinsett Rural Clean Water Project (RCWP) and others like it around the country will provide information for those in this state and country who make the water policy decisions about controlling nonpoint source pollution.

That's an analysis from Dr. Charles Ullery, Extension water and natural resources specialist at SDSU who was responsible for information and educational activities in the project.

The RCWP was a 10-year federal pilot demonstration project to use improved farming management practices in the watersheds in an attempt to improve quality of surface and ground water in Oakwood Lakes and Lake Poinsett in eastern South Dakota and the underlying Big Sioux Aquifer.

"This project has allowed us to learn about the nonpoint source pollution process, both in surface and ground water. We didn't know very much about that, especially ground water, before that project."

By "we" Ullery means the entire scientific community, regulatory community, legislative community, education community, and the agricultural community—all those involved in having an impact on water quality.

"This is the kind of location in the state where we are trying to learn how serious the water quality problems are in South Dakota and develop approaches toward minimizing pollution problems from agriculture," Ullery said.

By approaches, Ullery said he means "encouraging adoption of existing Best Management Practices that will protect

surface and ground water or encouraging development of new practices that will do a better job."

"It's safe to say that society has become much more sensitized to how agricultural production affects the environment," said Ullery.

"Today, society is saying: We want you to produce food and fiber, but we're not going to allow you to contaminate our surface and ground water in the process," Ullery added.

"Society is saying: We want you to start using practices which will minimize the risk of ground water and surface water pollution.

"So we will be encouraging producers to adopt cost-effective practices that will do a better job of protecting water quality. And if we in the regulatory, educational, and research institutions don't have those practices, we will ask the research community to come up with some better ways," said Ullery.

Ullery said the data from this and other studies like it will influence national as well as state water policy. The current USDA, EPA, and state nonpoint source pollution control programs use educational, technical, and financial assistance to encourage farmers to voluntarily adopt improved practices to protect water quality.

Many in the water policy area believe most recommended practices will be of the kind that "will be in the economic best interests for the producers to accept voluntarily."

If these approaches don't work, Ullery expects to see regulations such as the cross-compliance provisions for swamp-busting and sod-busting found in the 1985 Farm Bill.

In South Dakota, the major items of concern are nutrients, pesticides, sediment, and livestock wastes.

Ullery gave an example of what recommended and improved practices for nutrients might be:

1. A producer would begin by estimating a reasonable yield to expect from a crop in the year ahead, based on climate, rainfall, management level, and history of the land, and then set a yield goal.

2. From that yield goal, fertilizer managers can calculate how much of what nutrients the crop will need.

3. The next step would be to soil-test to determine kind and quantity of nutrients are already present.

4. Finally, the amount and kind of fertilizers to apply would be the difference between what the crop needs and what is available in the soil.

"In addition to that, we could use practices such as split applications during the year to assure that the crop gets the maximum use out of the fertilizer, to avoid applying excessive fertilizer, and to minimize risk of nutrients being lost in leaching or runoff," said Ullery.

"We feel if we manage fertilizers properly and avoid excessive applications, profitable crop yields can be produced while minimizing the risk of nitrogen being lost into the surface or ground water," Ullery said.

"We would use proper timing, proper method of application, all to optimize the availability of the nutrient to the plants. If manure was applied, it would be treated as a fertilizer credit in deciding how much commercial fertilizer to apply," said Ullery.

At the same time, educators and farm consultants like county Extension agents would discourage autumn and winter surface applications of fertilizer that might be washed away or that might leach through sandy soils.

Where irrigation is practiced, producers would make sure irrigation water is managed to optimize the use of fertilizer rather than run it off or leach it down, said Ullery.

". . . if we manage fertilizers properly . . . profitable crop yields can be produced while minimizing the risk of nitrogen being lost into the surface or ground water . . . "

--Charles Ullery

Objectives of fertilizer management would be to keep nitrogen from both ground water and surface runoff, and keep phosphorus from runoff, since it doesn't tend to move through the soil.

Ullery said that some soils and land pose a greater vulnerability to either surface or ground water pollution. Sloping land and soils with a low infiltration rate have a high potential for runoff, while sandy soils over shallow aquifers run a risk of contaminating ground water. "So we need to select practices and level of management to suit the situation."

Ullery said that, some years into the future, an individual farmer might inventory his or her farmland and characterize the potential problems for each field. In a particular field with runoff potential the farmer would use practices like conservation tillage and terracing to minimize runoff.

In contrast, a farmer with land over a shallow, sandy aquifer would have to be careful about managing nitrogen fertilizers and pesticides, said Ullery.

"What we're envisioning in the future, after a farmer inventories his or her resources, land, and soil, he or she would characterize the likely risk for either surface or ground water contamination and select appropriate practices that will minimize the risk of problems occurring," said Ullery.

Current state and federal water quality policy is to encourage producers to voluntarily adopt practices to minimize nonpoint source pollution, said Ullery. That emphasis is toward education and information to make farmers aware of recommended best practices. However, if agricultural producers don't move fast enough to solve problems voluntarily, Ullery envisions the possibility that public pressure would motivate some kind of regulatory programs at either the federal or state level on farming practices.

Managing very specific soils and geography could be done through each farm's Conservation Plan worked up in cooperation with the Soil Conservation Service.

A regulatory program might require farmers to keep records to show what practices were used to minimize water pollution potential and to document how they kept that risk below a certain level as defined by some regulatory agency.

This sort of regulation, if from the federal level, might occur in the form of the cross-compliance that came in the 1985 Farm Bill, where a person not using certain practices would not qualify for farm program benefits, Ullery said.

The kinds of practices farmers may be asked to adopt are apt to be the kind that would be economically neutral or beneficial to producers, yet protective of water quality. "We hope a lot of these practices will be self-perpetuating."

Fertilizer and pesticide management are management activities and are not capital-intensive, in contrast with a manure collection and storage facility where a farmer may be investing thousands of dollars, said Ullery.

Pesticide management, fertilizer management, and conservation tillage are believed to be the most practical and palatable way of addressing sediment control and nutrient and pesticide loss, the big issues in the Oakwood Lakes and Lake Poinsett areas, said Ullery. ❑

The writer is Jerry Leslie, communications specialist in the Ag Communications Department at SDSU.

photo: David German

Pickerel Lake's people care

All lakes dry up and die.

But, said Dave German of the SDSU Water Resources Institute, Pickerel Lake has been around for 12,000 years and isn't necessarily ready to blow away in a cloud of dust.

"Unless human beings start meddling. Then we override the natural aging process. We can kill a lake with overload of sediment and nutrients.

"At the present sedimentation rates, for which human activity is responsible, the Pickerel Lake basin would fill in in 2,000 years," German said.

"But Pickerel Lake is lucky. Its people care."

German, in digging up background on Pickerel Lake in northeastern Day County about 15 miles north of Waubay, found an old study that reported the sediment thickness in the north bay at 24 feet. Pollen layered in the sediment traces the transformation of the area from spruce forest to deciduous forest to prairie.

Pickerel is, in fact, the deepest natural lake in South Dakota, with a maximum depth of 43 feet and an average depth of 22 feet. It's far from large; it covers only about 955 acres and has less than 9 1/2 miles of shoreline.

There are over 300 homes, cabins, and trailer homes on the lake shore, two state parks, and several other access areas. The watershed covers about 15,000 acres in Day, Marshall, and Roberts counties.

"Pickerel is approaching old age," German said. "Its watershed appears to be contributing a dangerously high nutrient load, even though the watershed is small by South Dakota standards."

In the summer of 1990, Pickerel "turned over," according to German, with the first summer fish kill ever recorded on the lake.

When a lake turns over, the water mixes. German said turnover depends on the relative strengths of two opposing forces.

"One is wind energy, which wants to mix the whole lake. The other is inertia, generated by temperature differences from surface to bottom, especially in a deeper lake. Cooler water has a greater density and is at the bottom. But if the wind is strong enough, there'll be a turnover.

"Turnover isn't always bad, unless the oxygen has been removed from the deeper, colder water and poisonous gases have built up because of nutrient loads," he said. "And that happened at Pickerel.

"We were there just 2 days before the fish kill and saw it coming. We observed low oxygen and hydrogen sulfide in about two thirds of the lake's volume instead of just in the bottom layers."

The fish kill impressed landholders, who are now forming a sanitary district.

"That will help protect Pickerel."

Lake protection is German's business.

"Many of our South Dakota lakes are too far gone to be 'protected,' " he admitted. "They suffer from algal blooms all summer, every summer. They're usually shallow. They have so many nutrients in the sediments that they will continue to have algal blooms, even if we somehow miraculously stopped all fresh sediment and nutrients from entering the lakes from now on."

German emphasized that such lakes cannot be "restored" by simply preventing further nutrients and sediments from entering. "It will take sediment removal and nutrient inactivation to actually restore a lake." In some localities, dredging to remove nutrient laden sediments is part of "lake restoration" programs.

"Sediment removal is a delaying action," he said, "but if the lake is small, there may be some recreational use that can be salvaged."

Lake protection, on the other hand, gives German and Dr. Bob Bell, SDSU assistant professor of biology, an opportunity to work with lakes not so close to death. Bell collects, categorizes, and counts the various algal species found in the "priority" lakes.

German studies water quality in Pickerel Lake and is beginning to map the watershed. "When we have the details of present conditions, the Day Conservation District can help landowners set up the Best Management Practices that will be most effective for them."

Nonpoint Source Pollution Task Force lake protection priority list.

The top four are tied in total score and are most worth saving. Willow Creek at the bottom just made the list; it is a water storage reservoir with little to no recreational possibilities.

Lake	County
Newell	Butte
Deerfield	Pennington
Pactola	Pennington
Pickerel	Day
Enemy Swim	Day
Angostura	Fall River
Roy	Marshall
Cochrane	Deuel
Shadehill	Perkins
Clear	Marshall
Sheridan	Pennington
Richmond	Brown
Orman Dam	Butte
Mitchell	Davidson
Brant	Lake
Marindahl	Yankton
Wilmarth	Aurora
Minnewasta	Marshall
Stockade	Custer
Vermillion	McCook
Willow Creek Dam	Brown

In the summer of 1990, the South Dakota Nonpoint Source Task Force drew up a list of 21 lakes across the state that would benefit from lake protection.

"Most of these lakes are good candidates. They're in good enough shape that they are more likely to respond positively when we manage their watersheds. Most don't have large internal and self-sustaining sources of nutrients already in the lake," German said.

Protection is on a smaller scale than restoration, with less funding required and with more emphasis on detection and avoidance of potential problems.

"It's far easier and cheaper to prevent the decline of a lake than to try to restore it.

"It's a nice change to come from Big Stone and Oakwood lakes, which are pretty far gone, to work on one not so degraded," he commented.

Pickerel Lake is the first of the 21 lakes to receive attention. As in other state nonpoint source problems handled by the 319 Task Force, the project is coordinated by the Department of Environmental and Natural Resources while the SDSU Water Resources Institute coordinates field data collection. The Day Conservation District is sponsor of the project.

German and Bell spent part of last summer crisscrossing the state, gathering data on the 21 priority lakes. The work will be continued for several more years.

"Three visits each summer would no way give us enough information to go on," he said. "At some lakes the people filled in when we couldn't be there. They took Secchi disk recordings every week. We're still looking for volunteers for the other lakes. We had to have that information, and we appreciate all help."

Secchi disks are 8-inch-round disks painted in alternating black and white, with a string attached to the center. What the observer sees when the disk is suspended at a certain depth tells how opaque the water is. With formulas, German can relate the Secchi measurements to the amount of algae and the nutrient load in the lake at different times of the year.

"Most people don't realize how important lakes are to local tax bases and to the state's economy," German said. "When a lake looks good on the surface, it's hard to work up enthusiasm for preventive measures.

"But we've found great concern and excellent cooperation around some of these lakes. The people are ready to continue sampling. They're helping map the watershed and, in some cases, they're setting up sanitary districts without waiting to find out how much pollution septic tanks actually contribute."

At Pickerel, he thinks that could be a lot. Less than half of the land in the watershed is cropped. The rest is grassland, wetlands, and trees, "great nutrient traps" to hold sediment and pollutants from reaching the lake, he said. "But the shoreline has a heavy load of cottages and lake cabins."

Planned for Pickerel Lake and its watershed are improved or new animal waste management systems, shoreline stabilization, water quality monitoring, an intensive education program, and Best Management Practices which include grassed waterways, terraces, and crop residue retention.

"It comes down to a commitment of the people around Pickerel that they are not going to be responsible for the death of the lake," German said. "They've caught Pickerel in time." ❑

David German came to South Dakota in 1982 to work on Big Stone restoration and then on Oakwood Lakes, another restoration project. The writer is Mary Brashier, Experiment Station publications editor in the Department of Agricultural Communications, SDSU.

"It's far easier and cheaper to prevent the decline of a lake than to try to restore it."

--David German

photo: Kevin Schmidt

A drink to the future

The responsibility for protecting our drinking water supply doesn't rest in the hands of government officials alone. It also doesn't rest in the hands of farmers and ranchers alone.

"In point of fact, much of the responsibility belongs to the individual citizen."

That's the assessment of Russ Derickson, Extension associate with the SDSU Department of Ag Engineering and a specialist in water quality.

"It's short-sighted of us to depend totally on government programs and regulatory agencies for this important service," he continued.

"As individuals, we can do much to protect our drinking water just by practicing some common-sense precautions in our homes and businesses."

Derickson pointed out that homeowners sometimes apply dozens of times the recommended amounts of fertilizers, pesticides, and herbicides to their lawns and gardens. He said he knew of at least one instance where the fertilizer application rate on one man's lawn was equal to about 800 pounds per acre.

"Careless, abusive chemical use on a homeowner's lawn perhaps doesn't seem very significant compared to the amounts of chemicals used by agricul-

ture for our state, but this can be quite significant. Consider the area of all the lawns in all the cities and towns of the state, and I doubt if any single farm or ranch in the Midwest is any larger."

Derickson said another non-agricultural factor that is affecting drinking water supplies is the salt that some municipalities apply to roads and streets in winter time. As it melts, the chemicals eventually work their way into storm drains and, from there, into a stream or ground water. Some even may enter and contaminate the municipal well.

"The difficulty this presents is that sometimes all the storm water from a municipality is drained into a stream or river at a single point. This tends to concentrate and magnify the negative effect," he said.

When a city dweller flushes away a quantity of paint, oil, gasoline, garden spray, or other chemical, this also has a greater impact than if a farmer did the same thing, according to the specialist. Such disposal is routed to a water source in the same, concentrated way as storm water drainage from the city.

Derickson said city landfills also have an impact on drinking water supplies, especially if they are located over shallow aquifers. Individuals also can affect this by practicing recycling and proper disposal of harmful substances.

Overall, Derickson is satisfied that South Dakota is doing a good job of protecting its drinking water supplies.

Most aquifers also are in pretty good shape, although in isolated cases small aquifers have been pumped down dramatically.

He said the Missouri River will have increasing importance as a drinking water supply for larger municipalities. Smaller communities still are in good shape because their population trends are not putting additional stress on the supply.

Aberdeen and other communities already depend on the river, and Sioux Falls and Rapid City both eventually will take part of their supply from the river, he predicted.

"And that reminds me of a situation that too many of us are overlooking at present," he continued. "The amount of erosion and sedimentation in our mainstem dams on the Missouri may seriously curtail the amount of water they can store unless we give this some serious attention."

Derickson said the lifetime of the dams was originally estimated at 200 years. However, this estimate was made before the prairies adjacent to the dams began to come under cultivation.

"We need a strong service and educational effort to counteract this erosion and sedimentation," he said.

One SDSU researcher already has estimated that the cost of working with farmers to control erosion and sedimentation is but a small fraction of the cost of dredging sedimentation from the dams.

"Again, this is an educational effort that we as individuals need to seriously consider and support," he said.

Another need is for research. "We still don't know enough about how these chemicals interact with our water supplies and how to compound these chemicals to accomplish our needs without impacting water quality to such an extent," he said.

"While this is not something that we personally can accomplish, it is something we as individuals can support and encourage at institutions such as our state laboratories and universities," he explained.

Derickson, an SDSU graduate, has a bachelor of science degree in agricultural education and mechanical agriculture and a master of education degree in agricultural education and a minor in ag engineering. ❑

Dr. Larry Tennyson, writer of this article, is a communications specialist in the Department of Ag Communications, SDSU.

"As individuals, we can do much to protect our drinking water just by practicing some common-sense precautions . . . "

--Russ Derickson

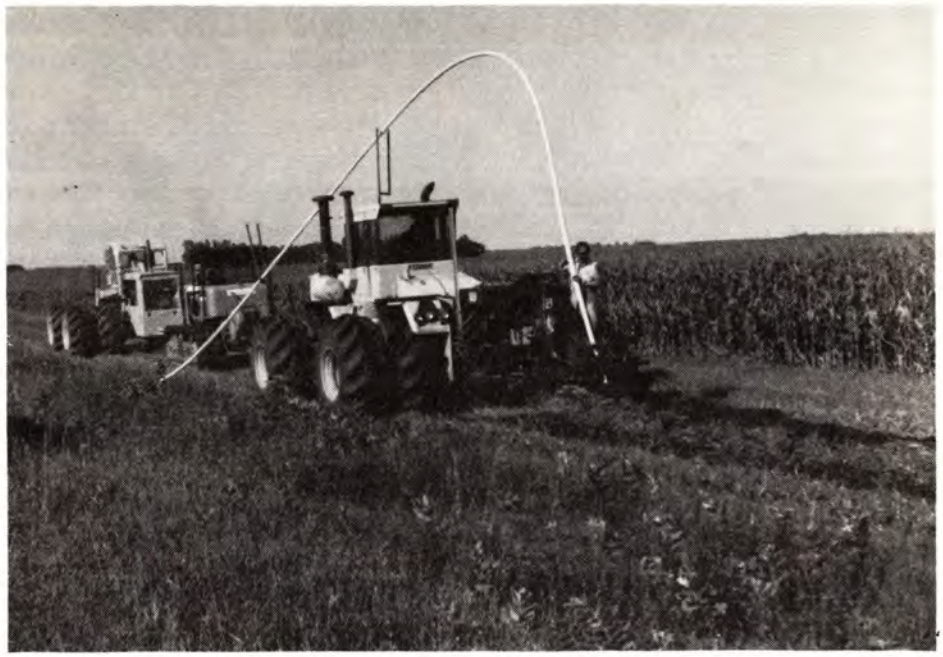

photo: South Dakota Rural Water Systems

Quality water now available to rural residents

by
Larry Tidemann

When eastern South Dakotans dug in their first rural water systems in the early 1970s, the projects were different from all other systems in the United States.

First, Extension county agents had sponsored initial meetings for potential users. Agents organized feasibility and interest surveys. They helped line up funding. They showed how such a large, community undertaking could be done, yet they dampened too-enthusiastic claims in favor of more practical expectations.

Second, Extension agents asked livestock feasibility questions in the surveys. This approach was novel at the time, but it rounded out the total cost-benefit picture. We now know that livestock productivity can be considerably higher when animals have access to good-quality water. We just have a hard time proving it to everybody's satisfaction.

Today, 5.5 billion gallons of water a year are delivered through 21,000 miles of pipe to 29,975 farms and ranches and 173 towns.

Statewide, 24 systems serve 130,000

South Dakotans. The networking is not yet complete—5,600 ranches and 72 towns are included in expansion plans.

Nearly every farmstead in eastern South Dakota is or can be hooked to a rural water system. The role of the Cooperative Extension Service in those early days is almost forgotten. Extension always bows out of a project once community leaders gain experience and can take over.

Some people won't forget that Extension helped bring high-quality water to many people. I'm one of them, along with Merlin Pietz, working in Turner and McCook counties, and Bob Schurrer from Clay County.

Just as construction began in Lincoln County on the very first rural water project in eastern South Dakota, I became County agent. By then, local leaders had taken firm command, and the Lincoln county Rural Water System became a showcase for the state and sparked interest in other counties.

It was a model project for many reasons. It had good leadership and strong local support. The times were right. Polyvinyl chloride plastic pipe that wouldn't corrode or collapse underground had been developed. There were new and more economical ways to lay pipe. Taxes on non-profit corporation assets had just been eased by the state legislature. Long-term, low-cost loans were available from FmHA.

The drought of 1976-77 spurred further interest in rural water systems in Lincoln County. A second network, the South Lincoln Rural Water System, was completed in 1982 in the rest of the county, plus the northern part of Union County and eastern parts of Turner County. It serves the towns of Chancellor, Alcester, and more farm operators than the original Lincoln County system.

photo: South Dakota Rural Water Systems

When the first rural water system tower went up in Lincoln County in the 1970 s, county Extension agents across eastern South Dakota helped form rural water districts by bringing people together, asking penetrating questions, and assessing local committment to the proposed projects. From the first, agents included livestock watering questions in feasibility surveys, questions which rounded out cost-benefit projections for the systems.

Some extravagant hopes and some equally expressive scoffing accompanied the formation of the first rural water system in Lincoln County.

When the dust settled, a 1979 research report from the SDSU Economics Department showed no or only modest increases in farmland values, compared to a part of the county not in the rural water system. The increase was not as great as users had expected.

On the other hand, rural residential acreages increased in value by $497 per acre within the water system area between 1970 and 1975.

In those days, a house built on an acreage in Lincoln County and hooked up to rural water probably meant a

photo: South Dakota Rural Water Systems

The Lincoln County Rural Water System had several things going for it when lines were dug in. PVC pipe that wouldn't collapse or corrode underground had just come on the market, there were new and more economical ways to lay the pipe, and low-cost, long-term loans were available. Most important to the success of this project, first rural water system in eastern South Dakota, was strong local leadership and community support.

house wasn't built in neighboring Sioux Falls. The county tax base expanded, but so did the need for more school rooms and better road and bridge upkeep. Economic spinoffs of the system were positive in some respects, less attractive in others.

The key to farmland and residential-acreage value was "driving distance." The researchers found that the closer to Sioux Falls, the higher the land values.

It doesn't take much thinking to see that the rural water system was not completely responsible for higher land prices "closer in." If people didn't have access to good roads, to telephone service, to electricity, if they didn't have their own personal reasons to move, then dependable water alone wouldn't have brought them out of the city.

Yet it played a part. Over half, 58 percent, of new non-farm residents in the Lincoln Rural Water System area said that the system influenced them to settle in the area.

Statistics mask some amazing personal stories.

A dairyman near Harrisburg believes that, to this day, his hookup hasn't cost him a penny. He had a deep well that needed repair every year. His water was so foul he couldn't get his milking equipment clean, but he still paid the electric bills to pump water.

Savings in soap and cleaner products alone, after he hooked up to the system, pays his total water bill, he says.

Another farmer couldn't raise pigs on his place because of high nitrates in the water. Now he sells pigs. He buys feeds and health products. We talk about the impact of agriculture; this is a prime example. His impact alone climbed from zero and ripples throughout the economy. The rural water system made it possible.

Other farmers in the Lincoln system suspected that poor quality water, high in nitrates and sulfates, was responsible for unseen livestock productivity losses. Their farm records now show an upswing in productivity, a swing that is difficult to document in general but definitely encouraging to individual operators.

Back in the 1970s we knew we had water problems. Over a third of water samples submitted to the State Health Department in Pierre were "unsafe for human consumption." Brackish groundwater carried iron and hardness concentrations among the highest in the U.S.

Poor water quality was, mostly, a natural problem. What if the rural water systems hadn't been built when they were? The Cooperative Extension Service is proud it has been able to work with community leaders in averting the disasters we might have faced. ❑

Larry Tidemann is program leader for agriculture with the South Dakota Cooperative Extension Service and is now stationed in Brookings.

photo: Duane Hanson

Drinking water: valuable and vulnerable

by
C. Gregg Carlson

The American public wants clean, safe water to drink, which is certainly not unreasonable. Since the accusation has been made that agriculture is polluting the nation's drinking water, some facts need to be put on the record.

We do know a great many things about ground water contamination. Not enough, because water is such a valuable resource.

We know that there are low concentrations of pesticides in some drinking water supplies around the nation. We can measure contaminants in water to the nearest part per trillion. There's the irony: In most cases, medical researchers only roughly know how these contaminants endanger the human body—at far greater concentrations than are currently being measured.

Infants have become ill or have even died—the "blue baby syndrome"—from drinking water carrying a high concentration of nitrate nitrogen. In most of those cases, the source of the nitrate contamination was traced to animal waste, not field applied fertilizer. Contamination from feedlots can be solved. The number of polluting feedlots is less today than 5 years ago. There will be fewer tomorrow.

Pesticides are of concern, but many agronomists believe that the most difficult problem we face is nitrate-nitrogen. It is found in many aquifers and comes from the decomposition of organic matter and fertilizer.

It is essential, for optimum crop production, to have adequate concentrations of nitrate-nitrogen in the soil solution. There are only limited alternatives to nitrogen fertilization, all of which have serious drawbacks.

The nitrate-nitrogen concentration of the soil water (in the top foot of the

soil profile) in a good, fertilized, growing corn field can be as high as several hundred parts per million (ppm). The EPA drinking water standard for nitrate-nitrogen is 10 ppm.

It is true that all farmers have an impact on ground water quality. However, when the issue is the drinking water consumed by most South Dakotans, then very few farmers have a significant impact.

Less than 10 percent—perhaps less than 5 percent—of the land area in South Dakota has any connection to the water that is most important to the vast majority of the population.

A little knowledge of hydrology clarifies that statement.

When water enters the ground and isn't stopped along the way, it migrates downward through the air spaces, or pores. It is pulled down by gravity until it reaches the point where all the spaces are filled by water. If pumping will yield usable amounts of water back to the surface, this is area is called an aquifer. Otherwise, it is simply a "saturated zone."

Flow typically occurs in aquifers. Not much—10 feet a day, a quarter of a foot, less.

An aquifer, however, is not a vast "underground lake." It is more like a bunch of separate fingers of water-containing sand and gravel. There are impermeable soil-profile layers weaving through the aquifer, blocking water movement. Lateral flow is quite often restricted.

Nor is perpendicular mixing particularly strong in an aquifer. Sampling of 118 shallow wells 8 to 50 feet deep was included in the Rural Clean Water Project around Oakwood and Poinsett lakes. Results showed that the concentration of nitrates in ground water from several different types of geological profiles drops off sharply 20 feet below the upper surface of the water.

This means that if ground water is being used for drinking purposes, the water should be withdrawn from deep in the saturated zone to reduce the possibility of nitrate-nitrogen concentration.

The slow lateral flow in an aquifer means that only the area around

Fertilizer management: sensible and simple

by
C. Gregg Carlson

Surveys connected with the South Dakota Rural Clean Water Program have shown that the state's farmers are committed to practices that allow them to produce food and fiber in an environmentally safe manner.

They already know and use many of those practices, and research is providing more. There is a potential practice I'd like to highlight. It seems so sensible as to be simple.

That practice is to more closely synchronize the timing of the ag chemical's application with the period of greatest need, when the plant is growing fastest. Such timing is already fairly common in herbicide and pesticide treatments, but needs to become more used in fertilizer applications.

This practice suggests split nitrogen applications. Since the highest rainfall months in South Dakota are usually May and June, splitting the nitrogen between planting, June 15, and July 15 gets the nutrient to the plants at the time of their greatest need and reduces

a wellhead will contribute most of the water to the well. For small municipalities in eastern South Dakota, this may be an area as small as 10 miles square, or less. The soils and the ag and non-ag activities in this area become critically important, if water percolating down carries contamination from agriculture or other industries.

Wellhead mapping is taking place across the country, and South Dakota is ahead of other states in data collection. Brookings County, for example, has identified its water resources, held public meetings, and, with help from the East Dakota Water Development District and some of us at SDSU, has mapped each area of vulnerability which could contaminate public water supplies.

An ordinance passed in 1989 controls land uses and requires increased protection measures on these areas of vulnerability within the wellhead protection areas. The ordinance permits only agriculture, horticulture, parks, and public utilities in these areas.

Performance standards were also set for land uses, whether or not they are in wellhead areas. The standards cover septic tanks, liquid waste ponds, petroleum storage, and feedlots.

Such standards permit an economic agriculture right up to the fence around the well pumping area. In contrast, in some places in Europe, agriculture in the primary zone of contribution to public water supplies is either limited to pasture or the farmer has to ask a water expert before he can apply fertilizer or pesticide.

The tension between public needs and private rights resurfaces in much of the controversy over water quality. Resolution will be based on shared knowledge and negotiation. Much of that knowledge is available through work the people involved in water quality are doing across the state.

Our water resource is valuable. It is vulnerable. We all can agree on that. When it comes to a good drink of water, there are no "sides." ❑

Dr. C. Gregg Carlson is associate professor of plant science at SDSU, with research responsibilities in water and saline and sodic soils. He teaches and is also Extension ground water specialist.

the potential for leaching, and there is no overdosing. The jury is still out on how this practice will affect yield. It sounds workable, but it means more trips over the field with machinery.

Any positive change in management rules out fall fertilizer applications. South Dakota crops are actively growing only about a third of the year.

Other ways to reduce ground water contamination are to choose the right formulation and the right rate for the situation at hand.

There are plenty of options to pick from. Every pesticide or fertilizer formulation has physical and chemical properties that make it unique as a compound and determine its ability to volatilize, to move, and to break down into inert substances.

From these properties, we can predict the behavior and fate of a compound after it has been applied to a soil. The USDA Goss Index, which categorizes pesticides and fertilizers into high, medium, and low leaching potentials, is available at SDSU. From it we can predict the relative leaching and/or runoff hazards associated with most labeled compounds.

And it still is true: Soil testing is the quickest, most effective, and most economical base of a cropping program to reduce nutrient load in ground water. SDSU researchers are currently refining and updating those tests to make them more efficient. ❑

Dr. C. Gregg Carlson is associate professor of plant science at SDSU, with research responsibilities in water and saline and sodic soils. He teaches and is also Extension ground water specialist.

photo: Ag Communicatons

The early days of Orman Dam

The Belle Fourche Irrigation Project is one of the earliest attempts to manage South Dakota's water resources, and it's also one of the oldest federal reclamation irrigation efforts in the United States—having been authorized by the Secretary of the Interior on May 10, 1904.

The project was not the earliest in western South Dakota, however. Private attempts at irrigation date to the 1870s when the valleys of the region were first being settled, according to former SDSU Rural Sociologist Marvin P. Riley and others in the 1955 report, "50 Years Experience on the Belle Fourche Irrigation Project," published as Bulletin 450 by the South Dakota Agricultural Experiment Station.

The Reclamation Act of 1902 made the Belle Fourche project possible, and records show that agitation for such a project in the northern Black Hills region began almost immediately thereafter. By the summer of 1903, the Department of Interior already had sent a reconnaissance team to survey area streams and determine the most feasible site for the project.

On May 10 of the following year, the Department set aside $2.1 million for the project, and the contract for building the diversion dam was let on April 24, 1905.

In just over 3 weeks, ground was broken.

Plans called for a diversion dam to be located on the Belle Fourche River just below the town of Belle Fourche. Water would be transported from there through a 6 1/2-mile inlet canal to a reservoir on Owl and Dry creeks that would be formed by Orman Dam.

The name "Orman," incidentally, may relate to Orman and Crook Construction of St. Louis, Mo. which won the contract for the project.

Orman Dam was to be one of the largest of its kind in the United States. The earthen structure was to hold 246,000 acre-feet of water with a reservoir surface of 9,000 acres.

From this structure, about 95,000 acres of land were to be irrigated from a distribution system consisting of the North and South Canals. The canals totaled 89 miles in combined length.

A third canal, the Johnson Lateral, also was planned. It would supply water from the inlet canal to about 3,000 acres south of the dam.

The diversion dam and the inlet canal were finished late in 1907, and a limited amount of irrigation began the following year. By 1910, the Belle Fourche Reservoir was sufficiently completed to enable storage of water, and the diversion works, inlet canal, reservoir, the South Canal, and part of the North Canal all saw service that summer.

Orman Dam was completed in 1911, and all other basic features of the project—including the Johnson Lateral—were essentially complete by June 1912.

The project required a substantial effort in technical assistance, and this gave rise to the Newell Irrigation and Dry Land Field Station established in 1907 and located just northwest of Newell, S.D.

The station mission was to provide farms with "research information on crops of local importance raised under dryland and irrigation agriculture," according to Riley.

Irrigation research was begun there in 1912, and in 1926 the South Dakota Agricultural Experiment Station at Brookings became actively involved with the livestock research conducted there.

The Cooperative Extension Service also became involved in the technical assistance effort. In addition to the continuing technical-assistance role of local agents, Extension also helped provide an irrigation specialist for farmers on the project from 1950 through 1952. ❑

Dr. Larry Tennyson, writer of this article, is a communications specialist in the Department of Ag Communications, SDSU.

research funding briefs

The SDSU College of Agriculture and Biological Sciences receives grants and contracts to support research and service projects. Funds received from July through November of 1991:

• $18,700 from the South Dakota Beef Industry Council for a study of the composition variability in the IMPS 103 beef rib. *John Romans, Animal & Range Sciences, project director.*

• $50,000 through the Northern Regional Agricultural Utilization Consortium for development of corn based foam plastics. *Jim Julson, Ag Engineering, and Padu Krishnan, Nutrition & Food Science, project directors.*

• $30,000 from the U.S. Department of Agriculture for soybean genome data base studies. *Tom Cheesbrough, Biology/Microbiology, project director.*

• $26,000 from the City of Brookings for bioconversion of cellulosic municipal solid wastes into ethanol fuel. *William Gibbons, Biology/ Microbiology, project director.*

• $49,930 through the Northern Regional Agricultural Utilization Consortium for increasing acetic acid/CMA productivity of clostridium. *William Gibbons, Biology/ Microbiology, project director.*

• $27,225 from the Governor's Office of Economic Development for CITE Project: En-R-G Livestock Feed Products. *Glen Harrison, Dairy Science, project director.*

• An additional $2,000 from the U.S. Small Business Administration for SDSU student teams to provide management consulting services to local businesses. *Richard Shane, Economics, project director.*

• An additional $53,620 from the Quaker Oats Company to develop superior oat varieties for this region. *Dale Reeves, Plant Science, project director.*

• An additional $2,000 from Pioneer Hi-Bred International for starter fertilizer studies with corn. *Howard Woodard, Plant Science, project director.*

• An additional $4,500 from the Fluid Fertilizer Foundation for development of a P model: phase I verification. *Howard Woodard, Plant Science, project director.*

• $124,950 from the South Dakota Wheat Commission for FY92 wheat research projects. *Dwayne Beck, George Buchenau, Fred Cholick, Sharon Clay, Billy Fuller, Jeff Gellner, Don Kenefick, Marie Langham, Clair Stymiest, all of Plant Science; and Padu Krishnan, Nutrition & Food Science, project directors.*

• $217,680 from the South Dakota Corn Utilization Council for FY92 corn utilization research projects. *Carl Birkelo, Animal Science, Jim Julson, Ag Engineering, Tom West, Biochemistry, David Schingoethe, Dairy Science, Leon Wrage & Paul Johnson, Plant Science, William Gibbons & Carl Westby, Biology/Microbiology, Padu Krishnan, Nutrition & Food Science, project directors.*

• $25,000 from the U.S. Fish and Wildlife Service to survey the biota of the riverine sections of the Missouri River in North and South Dakota. *Charles Berry, Wildlife & Fisheries Sciences, project director.*

• $16,500 from the U.S. Army Corps of Engineers for plover and tern habitat enhancement evaluations. *Ken Higgins, Wildlife & Fisheries Sciences, project director.*

• $38,690 through the Sport Fishing Institute for studies of thermal responses of a fish species. *David Willis and Robert Neumann, Wildlife & Fisheries Sciences, project directors.*

• $197,200 from the South Dakota Game, Fish and Parks Department for FY92 fisheries research projects. *Charles Berry, D. Duffy, David Willis, Wildlife & Fisheries Sciences, project directors.*

• $235,000 from the South Dakota Game Fish and Parks Department for FY92 wildlife research projects. *Les Flake, Ken Higgins, Daniel Hubbard, Jon Jenks, Wildlife & Fisheries Sciences, project directors.*

• $3,700 from the U.S. Department of Agriculture for 1991 research apprenticeship program. *Charles Berry, Wildlife & Fisheries Sciences, project director.*

• $5,000 from the U.S. Fish and Wildlife Service for evaluation of late-maturing cultivars of alfalfa for wildlife cover. *Ken Higgins, Wildlife & Fisheries Sciences, project director.*

• $20,000 from the North Dakota Game and Fish Department for evaluation of late-maturing cultivars of alfalfa for wildlife cover. *Ken Higgins, Wildlife & Fisheries Sciences, project director.*

• $10,000 from Ducks Unlimited, Inc. for evaluation of late-maturing cultivars of alfalfa for wildlife cover. *Ken Higgins, Wildlife & Fisheries Sciences, project director.*

• An additional $25,000 from U.S. Interior, Fish & Wildlife Service to study the effect of agricultural chemicals and non-point source pollutants on northern prairie wetlands. *W. Duffy, Wildlife & Fisheries Sciences, project director.*

research funding briefs

• $27,989 from U.S. Interior, Fish & Wildlife Service for delineation and classification of wetlands in western South Dakota. *Daniel Hubbard, Wildlife & Fisheries Sciences, project director.*

• An additional $5,368 from EG&G Idaho, Inc. for a study of man-made ponds. *Les Flake, Wildlife & Fisheries Sciences, project director.*

• $10,000 from the U.S. Department of Agriculture, Forest Service for ecology of the Northern Swift Fox in South Dakota project. *Charles Scalet and D. Uresk, Wildlife & Fisheries Sciences, project directors.*

• $13,873 from the Farmers Home Administration to produce an educational video tape. *Emery Tschetter, Ag Communications; project director.*

• $15,000 from the Quaker Oats company for a study of the beta glucan composition of South Dakota oats. *Padu Krishnan, Nutrition & Food Science, project director.*

• $2,750 from Con Agra, Inc. for analysis/measurement of fiber constituents in commercial oat samples. *Padu Krishnan, Nutrition & Food Science, project director.*

• $20,000 from Lilly Research Laboratories to find optimum monensin levels for controlling coccidiosis. *Robbi Pritchard, Animal & Range Science, project director.*

• $27,630 through the University of Minnesota, Northern Regional Agricultural Utilization Consortium to increase the salvage value of cull beef and dairy cows. *Robbi Pritchard, Animal & Range Science, project director.*

• An additional $88,000 through the University of Minnesota for Midwest initiative on water quality: northern corn-belt sand plain project. *Al Bender, Water Resources Institute, project director.*

• $19,500 through the University of Minnesota, Northern Regional Agricultural Utilization Consortium for development of Omega-3 fatty acid enriched pork products in the northern region. *John Romans, Animal & Range Science, and Mike Crews, Nutrition and Food Science, project directors.*

• $22,600 through the South Dakota Game, Fish and Parks Department for FY92 wildlife research projects. *Les Flake, Ken Higgins, Daniel Hubbard, Jon Jenks, Wildlife & Fisheries Sciences, project directors.*

• $18,000 from the U.S. Interior, Fish and Wildlife Service for Waubay private lands study. *Ken Higgins, Wildlife & Fisheries Sciences, project director.*

• An additional $4,000 from the U.S. Interior, Fish and Wildlife Service for distribution of carp in the Heron Lake Basin. *Charles Berry, Wildlife & Fisheries Sciences, project director.*

• An additional $55,979 from U.S. Interior, Fish and Wildlife Service for delineation and classification of wetlands in western South Dakota. *Daniel Hubbard, Wildlife & Fisheries Sciences, project director.*

• $25,000 through the University of Minnesota, Northern Regional Agricultural Utilization Consortium to develop feed management strategies to improve the economic value of cull cows. *George Libal, Animal & Range Science, project director.*

• An additional $5,500 from Select Sires for early detection by flow cytometry of reduced bovine semen quality resulting from environmental heat stress. *Don Evenson, Station Biochemistry, project director.*

• $22,917 from the South Dakota Department of Agriculture for technical assistance in the area of arboriculture and urban forestry to the State Forester. *Carter Johnson, Horticulture, Forestry, Landscape and Parks, project director.*

• $115,000 from the South Dakota Soybean Research and Promotion Council for soybean research projects. *Joe Bonnemann, Catherine Carter, Tom Chase, Tom Cheesbrough, C. Dybing, A. Gellner, Kathleen Grady, N. Reese, W. Riedell, Roy Scott, Dale Sorensen, Plant Science, project directors.*

• $105,201 from the U.S. Department of Agriculture, APHIS for FY92 grasshopper integrated pest management. *Billy Fuller, Plant Science, project director.*

• $57,910 from the South Dakota Groundwater Protection Fund for tillage induced microrelief impacts on nitrate and herbicide movement in soils. *David Clay, Sharon Clay, Joe Schumacher, Tom Schumacher, Dale Sorensen, Plant Science, project directors.*

• $10,325 from the Governor's Office of Economic Development and CMV Software Specialists, Inc. for veterinary diagnostic systems database. *John Thomson and David Benfield, Veterinary Science, project directors.*

• An additional $5,400 from South Dakota Game, Fish and Parks for FY92 fisheries research projects. *Charles Berry, D. Duffy, David Willis, Wildlife and Fisheries Sciences, project directors.*

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Calendar of Events

Date	Event	Person to Contact
March		
6	Women in Ag Conference, Holiday Inn, Mitchell	Burton Pflueger, Economics Dept. SDSU
23-24	Adolescent Nutrition Challenges Seminar, Brookings	Carol Pitts, Home Economics Dept. SDSU
25	Quest for Equity, SDSU	Joanne Sckerl, Conferences & Institutes, SDSU
31-April 1	Midstates Conference, South Sioux City, Nebraska	Larry Tidemann, Extension Ag Program Leader, SDSU
April		
3-4	Little International, SDSU	Dan Gee, Animal Science Dept. SDSU
5-7	State FFA Convention, SDSU	Bob Bell, State FFA Director, SDSU
9	Cleaning Products Videoconference	Linda Manikowske, Home Economics Dept. SDSU
29-May 1	Ag Communicators in Education (ACE) Regional Conference Champaign-Urbana, Illinois	Emery Tschetter, Ag Communications, SDSU
May		
6-9	Family Resource Coalition Conference, Chicago, Illinois	Lynette Olson, Home Economics Dept, SDSU